

Global Policy Spillovers: Evidence from the Multinational Automobile Industry

Koichiro Ito¹ James M. Sallee² Andrew Smith³

¹University of Chicago and NBER (ito@uchicago.edu)

²University of California, Berkeley and NBER

³University of Wisconsin–Madison

Motivation and research question

- **Motivation:** A country's policy affects multinational firms' products
 - ▶ Environmental regulations on cars, electric appliances, etc.
 - ▶ Safety regulations on equipment, medications, etc.
 - ▶ Firms may change product designs in response to policies

Motivation and research question

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 - ▶ Environmental regulations on cars, electric appliances, etc.
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 - ▶ Firms may change product designs in response to policies
- Do policy impacts spillover globally through product markets?
 - ▶ A country's policy affects products produced by multinational firms
 - ▶ If a product is sold worldwide, one country's policy may affect individuals in the rest of the world through the product market
- Economic analysis usually do not incorporate this possibility
 - ▶ Evaluations of domestic policies usually focus on domestic benefits
 - ▶ Many economic policies' impacts may have been understated

We examine this question in the international car markets

- Automakers often sell common models in many countries
 - ▶ The world best selling models (Toyota Carolla, Rav4, Honda Civic, CR-V etc.) are sold in many countries
 - ▶ A country's environmental policy might affect these products worldwide



Related literature

- Our focus is global spillover effects through the policy impact on product designs
- Related literature
 1. Spillover effects through the relocation of production
 - Pollution haven hypothesis—countries with weaker environmental regulations attract polluting industries, including local pollution
 2. Spillover effects through the exports of used products
 - Used cars (Davis and Kahn, 2010)
 - Used batteries (Tanaka, Teshima, and Verhoogen, 2022)

Outline

1. Introduction
2. Background
3. Difference-in-Differences Estimation
4. Structural Model
5. Counterfactual Policy Simulation
6. Conclusion

Background

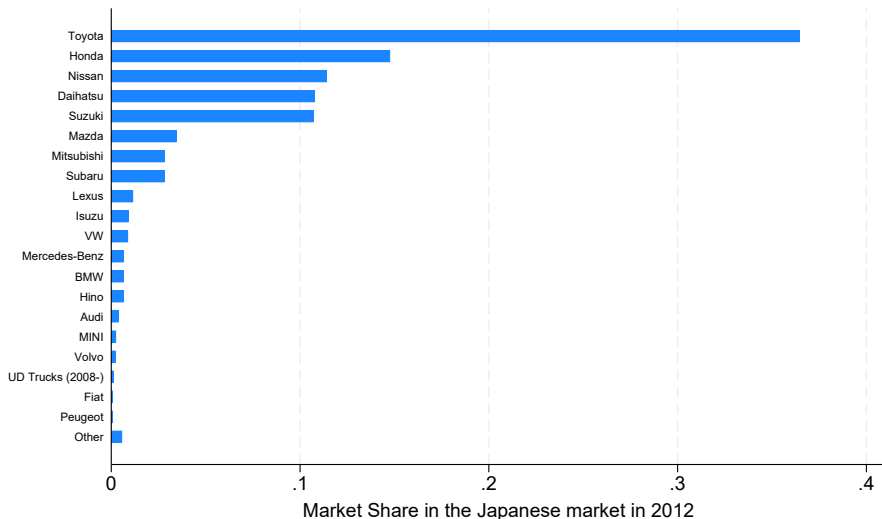
Policy: JPN government's subsidy for fuel-efficient vehicles

- “Eco-car” subsidy started in April, 2009
 - ▶ Consumers received a \$1,000 subsidy for a new car purchase if the model exceeds its 2015 fuel economy target
 - ▶ A stronger incentive for automakers to improve each model's fuel economy than the CAFE b/c the incentive was at the model level
 - ▶ Firms responded to it by improving fuel economy
- However, it was considered as an “expensive” policy
 - ▶ The government spent \$6.3 billion for the subsidy

Hypothesis: did the policy generate global spillovers?

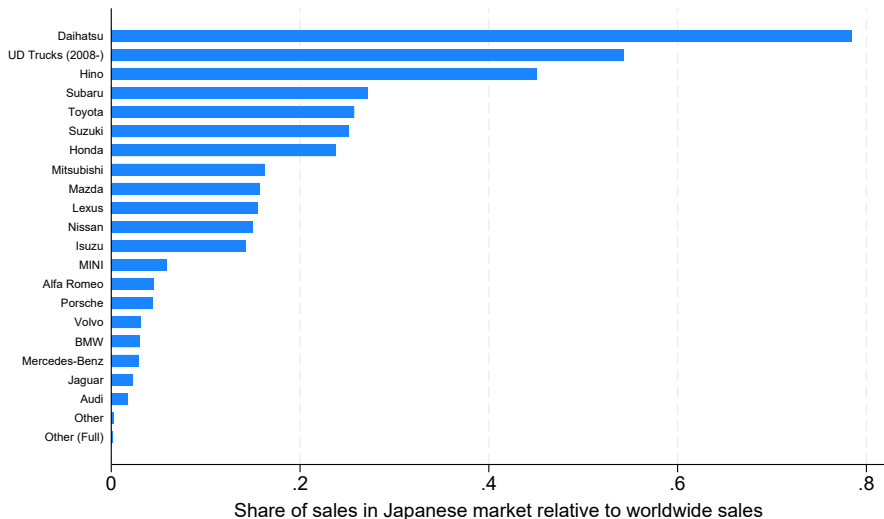
- What could be important factors for the potential spillover effect?
 - ▶ Firms face fixed costs of changing each model's product design
 - ▶ The subsidy incentive needs to be large enough to cover the fixed cost
- Conditions for **home country**:
 - ▶ The market has to be big enough for the model, otherwise it makes little sense for firms to respond to the subsidy's incentive
- Conditions for **spillovered country**:
 - ▶ Spillover impact is economically significant if the model's market share in the spillovered country is also larger

Which firms sell the most in the Japanese market?



- JPN firms dominate, European firms are second, and almost no American cars

Market share in Japan relative to a firm's worldwide sales



- JPN market is important for JPN & European firms, not so for American firms

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Difference-in-Differences Estimation

Identification strategy and data

- Identification strategy
 - ▶ Want to estimate JPN policy's impact on MPG of cars sold outside JPN
 - ▶ We use the difference-in-differences (DID) method
 - ▶ Time: before and after the policy introduction
 - ▶ **Treated**: models sold in home county (JPN) and spillovered country (US)
 - ▶ **Control**: the same firms' models sold in the US but NOT sold in JPN
- Data
 - ▶ Car characteristics data and sales data at the model level
 - ▶ Data sources: web-scraped car characteristics, sales from Marklines
 - ▶ Currently collected data for Japan, US, Germany, India
 - ▶ Linking models between countries is not obvious and needs careful work

Difference-in-differences for cars sold by JPN automakers

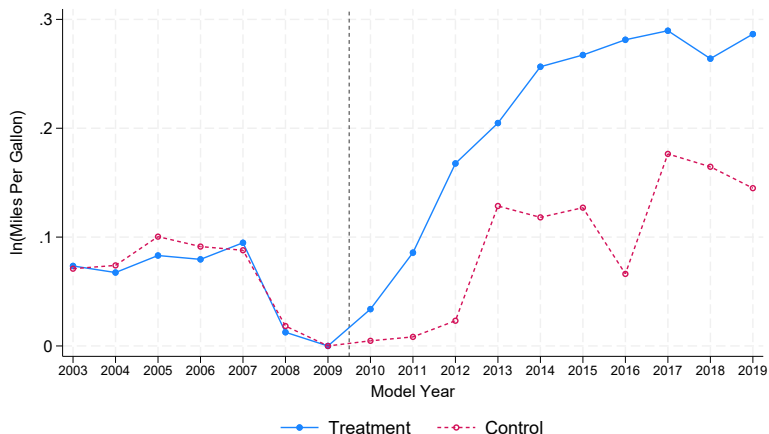
$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

- Variables:
 - ▶ MPG_{it} is miles per gallon for vehicle i and model year t in the US market
 - ▶ $Treated_i = 1$ if model i is also sold in Japan
 - ▶ $Post_t = 1$ after the introduction of the fuel-efficiency subsidy in Japan
 - ▶ X_{it} is a set of control variables (e.g, model and time fixed effects)
 - ▶ Standard errors clustered at the model level to adjust for serial correlation
- Identification assumption:
 - ▶ Parallel trend of MPG between 1) models sold in both countries and 2) models not sold in Japan

Japanese cars in the US market

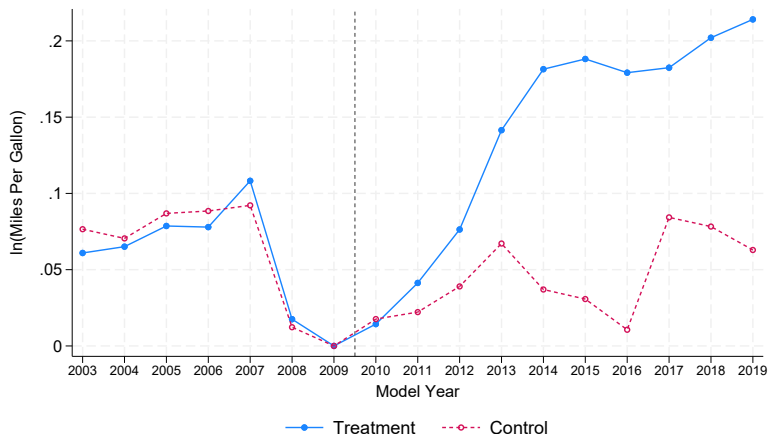
- US is the top 2 country in car sales (18.5% of the world sales)
- Japanese automakers have a 36.5% market share in the US

Average $\ln(\text{MPG})$ in the US market: Unweighted



- **Treatment:** Japanese cars sold in the US and Japan (90 models)
- **Control:** Japanese cars sold in the US but not in Japan (41 models)
- Vertical line: Introduction of the fuel-efficiency subsidy in Japan

Average $\ln(\text{MPG})$ in the US market: Weighted by sales



- **Treatment**: Japanese cars sold in the US and Japan (90 models)
- **Control**: Japanese cars sold in the US but not in Japan (41 models)
- Vertical line: Introduction of the fuel-efficiency subsidy in Japan

Spillover effects for Japanese cars in the US market

$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.106 (0.040)	0.101 (0.039)	0.078 (0.024)	0.073 (0.024)
Treated	0.297 (0.056)	0.298 (0.056)		
Post	0.001 (0.033)		0.007 (0.016)	
N	9,099	9,099	9,098	9,098
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Spillover effects:** 8~11% increase in fuel economy

American cars in the US market

- American automakers have a 45.1% market share in the US.
- American automakers have a 0.2% market share in Japan.

Spillover effects for American cars in the US market

$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.040 (0.049)	0.040 (0.048)	-0.019 (0.031)	-0.018 (0.031)
Treated	-0.102 (0.062)	-0.102 (0.062)		
Post	0.093 (0.033)		0.093 (0.023)	
N	1,329	1,329	1,325	1,325
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Treatment:** US cars sold in the US and Japan (59 models)
- **Control:** US cars sold in the US but not in Japan (144 models)
- Insignificant effects $\rightarrow$ could make sense b/c of the low market share in Japan

Japanese cars in the German market

- Germany is the top 5 country in car sales (3.9% of the world sales)
- Japanese automakers have a 9.8% market share in Germany

Spillover effects for Japanese cars in the German market

$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.083 (0.035)	0.076 (0.031)	0.078 (0.024)	0.076 (0.020)
Treated	-0.263 (0.114)	-0.263 (0.115)		
Post	0.061 (0.022)		0.047 (0.014)	
N	547	547	543	543
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- Treatment: Japanese cars sold in Germany and Japan (84 models)
- Control: Japanese cars sold in Germany but not in Japan (7 models)
- **Spillover effects:** 8% increase in fuel economy

Japanese cars in the Indian market

- India is the top 4 country in car sales (4.6% of the world sales)
- Japanese automakers have a 49.2% market share in India

Spillover effects for Japanese cars in the Indian market

$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.173 (0.135)	0.144 (0.142)	0.285 (0.056)	0.272 (0.060)
Treated	-0.016 (0.139)	-0.016 (0.143)		
Post	0.115 (0.123)		-0.006 (0.009)	
N	147	147	145	145
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Treatment:** Japanese cars sold in India and Japan (29 models)
- **Control:** Japanese cars sold in the India but not in Japan (13 models)

Heterogeneity in the spillover effects

- Car models that were similar between Japan and US before the policy shock may have shared more common design/platform/inputs
- These models may get larger spillover effects in the US market
- **Hypothesis:** "Differentiated" models may get less spillover effects

Heterogeneity in the spillover effects

Dependent variable: $\ln MPG_{it}$			
	(1)	(2)	(3)
Treated $\times$ Post	0.073 (0.024)	0.119 (0.027)	0.088 (0.025)
Treated $\times$ Post $\times$ Differentiation 1		-0.218 (0.071)	
Treated $\times$ Post $\times$ Differentiation 2			-0.184 (0.072)
N	9,098	7,159	7,159
Year FE	Yes	Yes	Yes
Model FE	Yes	Yes	Yes

- Differentiation 1 = $|\ln(MPG_{i,JP,2008}) - \ln(MPG_{i,US,2008})|$
- Differentiation 2 = $(MPG_{i,JP,2008} - MPG_{i,US,2008})^2$
- Confirms that models with higher differentiation between Japan and US experienced smaller spillover effects

Pass-through rate of the spillover effects

- How large was the spillover effects relative to the "direct effects" of the policy in the home country?

Pass-through rate of the spillover effects

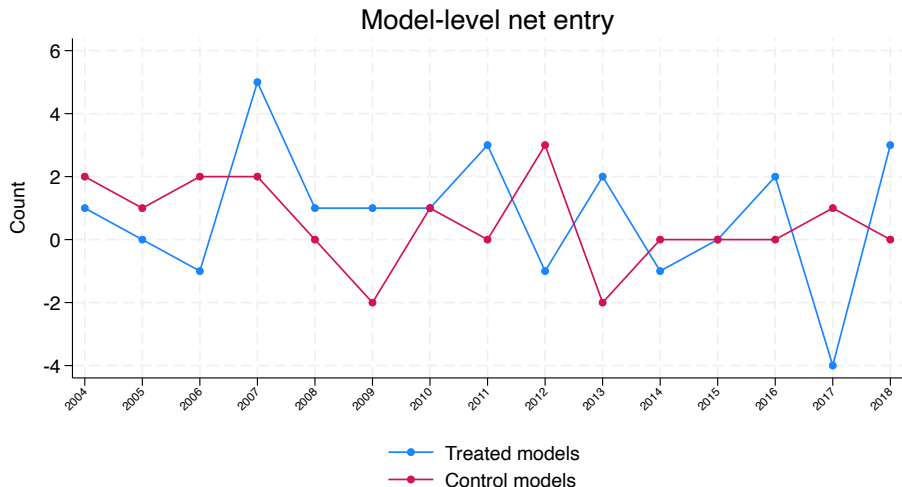
Dependent variable: $\ln MPG_{it}$			
	JPN models in US	JPN models in JPN	Stacked regression
Treated in Japan $\times$ Post		0.207 (0.080)	0.207 (0.082)
Treated in US $\times$ Post	0.073 (0.024)		0.073 (0.024)
Year FE	Yes	Yes	Yes
Model FE	Yes	Yes	Yes
Difference in Japan-US coefficients			0.134
Standard error of difference			0.082
Ratio of US-Japan coefficients			0.354
Standard error of ratio			0.169

- Control group: Japanese models sold in the US but not in Japan
- Result suggests that the spillover pass-through rate = 35.4%

Did the policy affect product entry/exit?

- Did the policy affect product entry/exit? Or, did the spillover effect mainly come from changes in car characteristics?

No spillover impact on product entry/exit



All Japanese models in the US car market.

Summary of the DID results and welfare implications

- The Japanese fuel-economy subsidy induced global spillover effects:
 - ▶ Mostly through products sold by Japanese automakers
 - ▶ Spillover effects were economically significant (e.g. 8~11% increase in fuel economy in the US market)
- What were the welfare effects of this spillover for the US economy?
 - ▶ Consumers were likely to benefit from the improved fuel economy
 - ▶ However, this does not necessarily imply a higher consumer surplus
 - Firms may have increased prices
 - Firms may have increased markups
 - There could be indirect equilibrium effects on unaffected cars
- We build a model of multinational car markets to study these questions

Impact on other attributes: JPN cars in US market

$$\ln \text{Attribute}_{it} = \alpha \text{Treated}_i \times \text{Post}_t + \beta \text{Treated}_i + \gamma \text{Post}_t + \delta X_{it} + \epsilon_{it}$$

	(1) MPG	(2) Horsepower	(3) Price	(4) Wheelbase	(5) Footprint	(6) Weight
Treated $\times$ Post	0.073 (0.024)	-0.080 (0.030)	-0.039 (0.024)	-0.010 (0.008)	-0.008 (0.010)	-0.025 (0.019)
N	9,098	9,134	9,124	9,134	9,134	9,120

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A Model of Multinational Car Markets

Our model has two goals

1. Model and estimate a potential mechanism of global policy spillovers
 - ▶ Build on a standard differentiated-product market model (BLP, 1995)
 - ▶ Extend it to incorporate **multinational markets**
 - ▶ Extend it to incorporate firms' **endogenous attribute choices**
 - ▶ Model & estimate potential **cross-market links** in revenues and costs
2. Investigate the welfare implications of the global policy spillover effect
 - ▶ Consumer surplus
 - ▶ Producer surplus
 - ▶ Environmental externalities
 - ▶ Social welfare

Overview of the model

- Multinational firms maximize their profits in two countries
 - ▶ A **home country** where a policy intervention occurs (Japan in our case)
 - ▶ A **spillovered country** (United States in our case)
- Demand
 - ▶ A standard random-utility framework with random-coefficient logit
 - ▶ Consumer preferences are allowed to be different between countries
 - ▶ i.e. We estimate each country's demand system separately
- Supply
 - ▶ We consider a multinational multi-product firms that sell products $j \in J_f$
 - ▶ Marginal cost c_j is allowed to be different between countries
 - ▶ Firms also have fixed costs of improving fuel economy FC_j (Fang, 2013)
 - ▶ We allow FC_j to have cross-market complementarity

1) Demand—A random utility model for new car purchases

- p_{jc} : price for product j in market c
- x_{jc} : a vector of product characteristics for product j in market c
- Conditional indirect utility of consumer i who purchases product j

$$u_{ijc} = \beta_i x_{jc} + \alpha_i p_{jc} + \xi_{jc} + \epsilon_{ijc}$$

- ▶ ξ_{jc} : unobserved factors at the market-product level
- ▶ ϵ_{ijc} : unobserved factors at the market-product-consumer level (type-I extreme value)

1-1) Standard Logit Demand Approach

$$u_{ijc} = \beta_i x_{jc} + \alpha_i p_{jc} + \xi_{jc} + \epsilon_{ijc}$$

- First, assume that β and α do not depend on i
- The probability that consumer i in market c chooses product j is:

$$P_{ijc} = \Pr(U_{ijc} > U_{ij'c}) \forall j' = \frac{\exp(\beta x_{jc} + \alpha p_{jc} + \xi_{jc})}{\sum_{j'=0}^J \exp(\beta x_{j'c} + \alpha p_{j'c} + \xi_{j'c})}$$

- Note that P_{ijc} does not depend on i . Then, the sum over i will be:

$$\sum_{i=1}^{N_c} P_{ijc} = N_c \cdot \frac{\exp(\beta x_{jc} + \alpha p_{jc} + \xi_{jc})}{\sum_{j'=0}^J \exp(\beta x_{j'c} + \alpha p_{j'c} + \xi_{j'c})}$$

1-1) Standard Logit Demand Approach

- The market share for product j in city c is:

$$s_{jc} \equiv \frac{1}{N_c} \sum_{i=1}^{N_c} P_{ijc} = \frac{\exp(\beta x_{jc} + \alpha p_{jc} + \xi_{jc})}{\sum_{j'=0}^J \exp(\beta x_{j'c} + \alpha p_{j'c} + \xi_{j'c})}$$

- The market share for the outside option S_{0c}
 - ▶ The outside option is not to buy product $j = 1, \dots, J$
 - ▶ This market share is usually unobservable from a dataset
 - ▶ A typical approach is to assume that S_{0c} is the number of consumers (households) in market c that did not buy any product j
 - ▶ Consumers obtain zero utility if they do not purchase any of product j

$$s_{0c} = \frac{\exp(0)}{\sum_{j'=0}^J \exp(\beta x_{j'c} + \alpha p_{j'c} + \xi_{j'c})}$$

1-1) Standard Logit Demand Approach

- Log market share for j minus log market share for outside option:

$$\ln s_{jc} - \ln s_{0c} = \beta x_{jc} + \alpha p_{jc} + \xi_{jc}$$

- An advantage of this method is that it is just a linear equation
- An disadvantage is that it assumes restrictive substitution patterns: the Independence of Irrelevant Alternatives (IIA) assumption

1-2) Random Coefficient Logit Approach

- Allow heterogeneity in β and α

$$u_{ijc} = \beta_i x_{jc} + \alpha_i p_{jc} + \xi_{jc} + \epsilon_{ijc}$$

- ▶ e.g. $\beta_i = \beta_0 + \beta_1 D_i + u_i$
 - ▶ e.g. $\alpha = \alpha_0 + \alpha_1 D_i + e_i$,
 - ▶ Explain taste heterogeneity by demographic variables (D_i) and a random term $u_i \sim N(0, \sigma_\beta)$ and $e_i \sim N(0, \sigma_\alpha)$
- **Advantage:** Allow for flexible substitution patterns, less restrictive price elasticity, and heterogeneous tastes
 - **Challenge:** Non-linear GMM requires numerical simulation. Need careful implantation to obtain global optimal GMM estimates (Knittel and Metaxoglou 2013, Conlon and Gortmaker 2020)

2) Supply

- Multinational multi-product firm f 's profit can be written by:

$$\text{Japan: } \pi_f = \sum_{j \in J_f} \left[\left(p_j - c_j(e_j, x_j) \right) \cdot q_j(p_j - \tau_j(e_j), e_j, x_j) \right]$$

$$\text{US: } \hat{\pi}_f = \sum_{j \in \hat{J}_f} \left[\left(\hat{p}_j - \hat{c}_j(\hat{e}_j, \hat{x}_j) \right) \cdot \hat{q}_j(\hat{p}_j, \hat{e}_j, \hat{x}_j) \right]$$

- ▶ J_f : the set of cars sold by firm f
 - ▶ p_j : the price of car j
 - ▶ c_j : marginal cost
 - ▶ e_j : fuel economy
 - ▶ x_j : a vector of other attributes
 - ▶ q_j : demand = (market size) $\cdot s_j$
 - ▶ $\tau_j(e_j)$: the fuel-economy subsidy in Japan
- Firm f maximizes $\pi_f + \hat{\pi}_f - \sum_j FC(e_j, \hat{e}_j)$ w.r.t. $(p_j, e_j, \hat{p}_j, \hat{e}_j)$
 - ▶ $FC(e_j, \hat{e}_j)$ is the fixed cost of improving fuel economy

2-1) Estimation of the marginal cost

- Our approach builds on Berry, Levinson, and Pakes (1995)
- Firm's first order condition with respect to price (p_j) implies:

$$q_j + \sum_{k \in J_f} \left[(p_k - c_k(e_k, x_k)) \cdot \frac{\partial q_k}{\partial p_j} \right] = 0$$

- This equation and demand estimation provides us an estimate of c_k
- We regress c_k on attributes to estimate the marginal cost function
- We model the cost function with the Cobb-Douglas production function

$$\ln c_k = \beta_1 + \beta_2 \ln e_j + \beta_3 \ln x_j + \eta_j$$

- We estimate this separately for each country to allow heterogeneity

2-2) Estimation of the slope of the fixed cost

- Our approach builds on Fan (2013) and Barwick, Kwon, and Li (2024)
- Firm's first order condition with respect to fuel economy (e_j) implies:

$$-\frac{\partial c_j}{\partial e_j} \cdot q_j + \sum_{k \in J_f} \left[\left(p_k - c_k(e_k, x_k) \right) \cdot \frac{\partial q_k}{\partial e_j} \right] = \frac{\partial FC(e_j, \hat{e}_j)}{\partial e_j}$$

- This equation provides an estimate of the marginal fixed cost $\frac{\partial FC(e_j, \hat{e}_j)}{\partial e_j}$
- Similarly, the FOC w.r.t. $\hat{e}_j$ provides an estimate of $\frac{\partial FC(e_j, \hat{e}_j)}{\partial \hat{e}_j}$

2-2) Estimation of the slope of the fixed cost

- Model the fixed cost function by $FC(e_j, \hat{e}_j) = \gamma_0 + \gamma_1 \bar{e}_j + \gamma_2 (e_j - \hat{e}_j)^2$
 - ▶ $\bar{e}_j$ = car j 's average fuel economy across the two countries $\equiv w_j e_j + \hat{w}_j \hat{e}_j$
 - ▶ w_j and $\hat{w}_j$ are car j 's sales shares between Japan and US
 - ▶ $(e_j - \hat{e}_j)$: the deviation of fuel economy between the two markets
 - ▶ γ_1 is the marginal fixed cost of improving car j 's average fuel economy
 - ▶ **Hypothesis:** $\gamma_2 > 0$ if there is a cross-market complementarity
- The derivatives with respect to e_j and $\hat{e}_j$ imply:

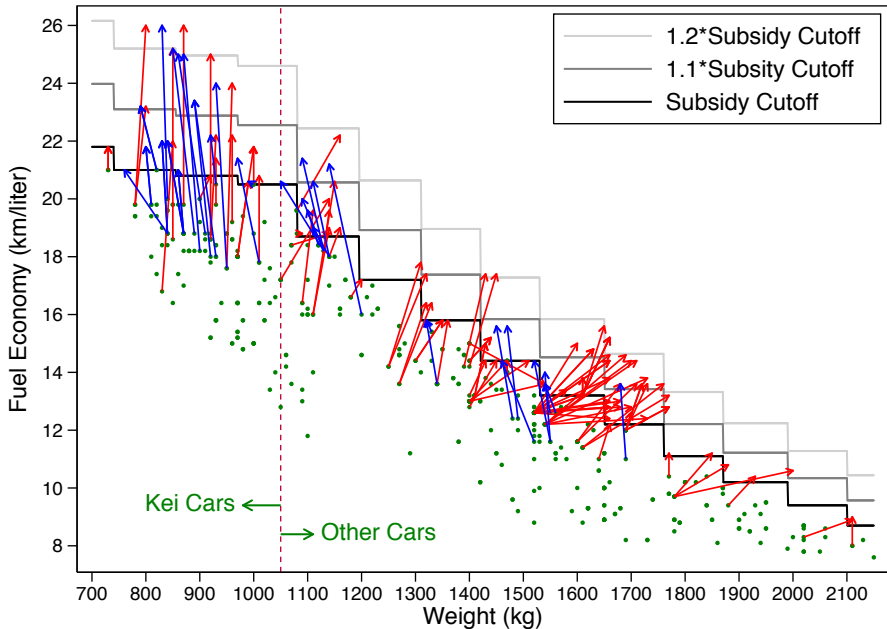
$$\frac{\partial FC(e_j, \hat{e}_j)}{\partial e_j} = \gamma_1 w_j + 2\gamma_2 (e_j - \hat{e}_j)$$

$$\frac{\partial FC(e_j, \hat{e}_j)}{\partial \hat{e}_j} = \gamma_1 \hat{w}_j - 2\gamma_2 (e_j - \hat{e}_j)$$

- We fit data to these equations to estimate γ_1 and γ_2

Instruments

- Standard BLP considers that firms endogenously choose p_j only
 - ▶ BLP uses rivals' product characteristics as instruments for p_j
- In our model, we allow firms endogenously choose p_j and e_j
 - ▶ This means that we need an instrument for e_j
 - ▶ The instrument needs to be correlated with e_j
 - ▶ The instrument needs to be uncorrelated with the error terms
- We use a unique feature of the Japanese subsidy to create an IV
 - ▶ To be qualified for the subsidy, e_j needed to be above the target
 - ▶ The fuel-economy target was a non-linear step function (next page)
 - ▶ This created variation in easiness/difficulties to qualify for the subsidy
 - ▶ This variation created a policy-induced change in e_j in policy period
 - ▶ Recall that the subsidy was introduced in 2009
 - ▶ We create $\tilde{\Delta}e_j = e_j^{\text{target}} - e_{j,2008}$ as an instrument for e_j



• This figure is from Ito and Sallee (2018)

1) Demand estimation results

	Japan	US
Price/Income (USD)	-1.513 (0.379)	-2.005 (0.180)
Fuel economy (mpg)	0.174 (0.019)	0.049 (0.008)
Horsepower	0.008 (0.003)	0.005 (0.001)
Vehicle weight (US tons)	1.459 (0.215)	0.023 (0.070)
sigma	22.799 (.0004)	29.479 (0.0001)
Observations	2142	2139

- Sigma is the standard deviation for the log-normal random-coefficient for price

2) Marginal cost estimation results

$$\ln c_k = \beta_1 + \beta_2 \ln e_j + \beta_3 \ln x_j + \eta_j$$

	Japan		US	
	(1)	(2)	(3)	(4)
$\ln e_j$	0.470 (0.026)	0.509 (0.029)	1.339 (0.189)	1.140 (0.175)
$\ln hp_j$	0.405 (0.036)	0.237 (0.037)	2.396 (0.129)	1.745 (0.120)
$\ln weight_j$	2.294 (0.054)	2.467 (0.053)	2.125 (0.160)	2.651 (0.157)
Constant	-9.903 (0.270)		-24.780 (1.779)	
Firm FE	No	Yes	No	Yes
Observations	2142	2142	1707	1707

3) Estimation results of marginal fixed cost

$$FC(e_j, \hat{e}_j) = \gamma_0 + \gamma_1 \bar{e}_j + \gamma_2 (e_j - \hat{e}_j)^2 \quad (1)$$

	(1)	(2)
γ_1	5.87 (0.180)	6.76 (0.253)
γ_2	0.079 (0.016)	0.115 (0.018)
Firm FE	No	Yes
Observations	4281	4281

- The monetary unit is one million USD. The unit of e_j is miles/gallon.
- $\gamma_2 > 0$ suggests the evidence of cross-market complementarity

3) (Preliminary) Investigating potential heterogeneity

$$FC(e_j, \hat{e}_j) = \gamma_0 + \gamma_1 \bar{e}_j + (\gamma_2 + \gamma_3 D_j)(e_j - \hat{e}_j)^2 \quad (2)$$

	(1)	(2)
γ_1	5.29 (0.185)	5.71 (0.268)
γ_2	0.298 (0.023)	0.315 (0.024)
γ_3	-0.310 (0.041)	-0.325 (0.040)
Firm FE	No	Yes
Observations	3622	3622

- $D_j = 1$ if both Japan and North America have plants that produce car j
- Results are preliminary as we keep collecting production information
- This suggests the cross-market complementarity is likely to come from cars that are produced in a common plant and export to both countries

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Counterfactual Policy Simulation

Counterfactual policy simulation

- What if Japan *did not* implement the fuel-economy subsidy?
 - ▶ Lowers demand for fuel-efficient cars in Japan
 - ▶ Lowers incentives for firms to improve fuel-economy
 - ▶ Lowers fuel-economy in the US
 - ▶ Firms' optimal choices of e_j & p_j would change
 - ▶ What are the effects on consumer & producer surplus and social welfare?
- We use our model to simulate two scenarios:
 - ▶ Actual scenario (with the fuel-economy subsidy in Japan)
 - ▶ Counterfactual scenario (remove the fuel-economy subsidy in Japan)
 - ▶ Quantify the Japanese policy's global spillover effects on the US market

Global spillover effects on the US car market

	Actual scenario	Counterfactual scenario	Spillover impact (level)	Spillover impact (%)
Fuel economy subsidy in Japan	Yes	No		
Average fuel economy (miles per gallon)	24.05	22.40	1.65	7.39
Average price (USD/car)	34,077	32,987	1,090	3.31
Consumer surplus (billion USD/year)	420.43	407.36	13.07	3.21
Producer surplus (billion USD/year)	357.99	345.78	12.21	3.53
Environmental externality cost (billion USD/year)	21.17	22.83	-1.66	-7.25
Social welfare (billion USD/year)	757.25	730.31	26.94	3.69

- Japan's fuel-economy subsidy resulted in welfare effects in the US:
 - ▶ **Increased** average fuel economy and price
 - ▶ **Reduced** environmental externality cost
 - ▶ **Increased** consumer surplus, producer surplus, and social welfare

Conclusion

Conclusion

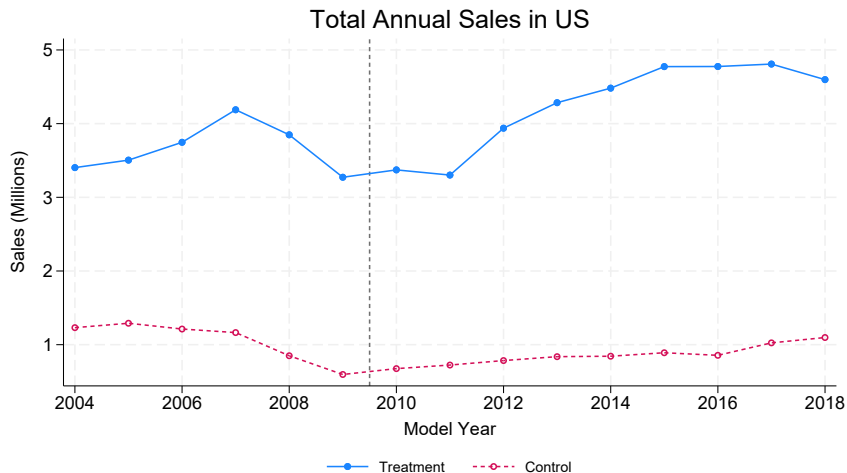
- We study global policy spillovers through multinational firms
 - ▶ Policy impacts may spillover globally through multinational firms
 - ▶ This effect may spillover globally if the product is sold worldwide
 - ▶ We examine this question in the international car markets
- Difference-in-differences estimation
 - ▶ The Japanese fuel-economy subsidy induced global spillover effects
 - ▶ Spillover effects were economically significant (e.g. 8~11% increase in fuel economy in the US market)
- A Model of multinational car markets and policy simulations
 - ▶ Japan's fuel-economy subsidy induced welfare effects in the US
 - ▶ **Increased** average fuel economy and price
 - ▶ **Reduced** environmental externality cost
 - ▶ **Increased** consumer surplus, producer surplus, and social welfare

Thank you!

Feedback/suggestions? ito@uchicago.edu

Appendix

Sales over time



- Electricity is a major source of GHG emissions (e.g., 25% in the US)
- Another large source is transportation, which can be electrified soon

Spillover effects for Japanese cars in the US market (Unweighted)

$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.118 (0.061)	0.114 (0.059)	0.063 (0.017)	0.061 (0.016)
Treated	0.216 (0.043)	0.217 (0.043)		
Post	0.053 (0.050)		0.013 (0.013)	
N	1,245	1,245	1,238	1,238
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Spillover effects:** 6~11% increase in fuel economy

JPN cars in Germany market (Control: US)

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.147 (0.046)	0.112 (0.040)	0.115 (0.025)	0.081 (0.023)
Treated	0.595 (0.062)	0.628 (0.056)	-0.106 (0.022)	-0.080 (0.020)
Post	-0.003 (0.037)		0.010 (0.017)	
N	793	793	790	790
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Treatment:** Japanese cars sold in Germany and Japan (84 models)
- **Control:** Japanese cars sold in the US but not in Japan (41 models)

JPN cars in India market (Control: US)

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.382 (0.050)	0.365 (0.050)	0.319 (0.035)	0.286 (0.031)
Treated	0.481 (0.066)	0.491 (0.069)	-0.107 (0.028)	-0.042 (0.029)
Post	-0.016 (0.036)		0.010 (0.017)	
N	424	424	423	423
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Treatment:** Japanese cars sold in India and Japan (29 models)
- **Control:** Japanese cars sold in the US but not in Japan (41 models)

European cars in the US market

- European automakers have a 8.5% market share in the US.
- European automakers have a 4.6% market share in Japan.

Spillover effects for European cars in the US market

$$\ln MPG_{it} = \alpha Treated_i \times Post_t + \beta Treated_i + \gamma Post_t + \delta X_{it} + \epsilon_{it}$$

	(1)	(2)	(3)	(4)
Treated $\times$ Post	0.069 (0.049)	0.072 (0.052)	0.108 (0.016)	0.095 (0.022)
Treated	-0.151 (0.075)	-0.153 (0.074)		
Post	0.055 (0.045)		0.009 (0.012)	
N	962	962	959	959
Year FE	No	Yes	No	Yes
Model FE	No	No	Yes	Yes

- **Treatment:** EU cars sold in the US and Japan (95 models)
- **Control:** EU cars sold in the US but not in Japan (43 models)